ON THE EVIDENCE (SO-CALLED) OF GLACIER ACTION ON MOUNT KOSCIUSKO PLATEAU.

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(Plates xxxvii.-xxxix.)

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In January, 1885, Dr. R. von Lendenfeld made a visit to Mount Kosciusko. Shortly afterwards he issued a Report* dated 21st of January, 1885, and addressed to the Minister for Mines, in which he states that he found "rocks polished by Glacial Action"† in many places. Sometime afterwards he published a paper entitled "The Glacial Period in Australia."‡ Dr. Lendenfeld comes to the conclusion that Glaciers extended from a high Plateau, Mount Kosciusko—down into the valleys around; he noted that in these valleys "most beautiful and indubitable traces of glacial action";§ that evidences of Glaciation were "found in the shape of *Roches Moutonnées* scattered over an area of one hundred square miles."|| There can be no doubt Dr. Lendenfeld is referring to a Post-Tertiary Glaciation, for he adds, "that portion of Australia was, therefore, not so long ago, certainly covered with ice."¶ More recently Mr. Richard Helms accepted

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* Report by Dr. R. von Lendenfeld on the results of his recent examination of the central part of the Australian Alps. Sydney. Thos. Richards, Government Printer. 1885.

† Dr. Lendenfeld's Report, p. 10.

‡ Proc. Linn. Soc. N.S.W. (1st Series), Vol. x. p. 48.

§ *Loc. cit.*, p. 47.

|| *Loc. cit.*, p. 50.

¶ *Loc. cit.*, p. 50.

these conclusions and contributed a paper* to this Society embodying some fresh observations. Mr. Helms concludes that there are "evidences of extensive glacier action at Mount Kosciusko," and that "many of the rounded, concave, and level surfaces found upon a number of the large rock facings have been produced by glacier action, although the minute features of it have long since been destroyed by erosion and decomposition."†

The present writer spent three weeks on the Kosciusko Plateau since the publication of the papers referred to. On my first trip I was accompanied by Mr. Charles Hedley, of the Australian Museum, and Mr. James Petrie, of the University. The route traversed is shown on the accompanying map. This record of the routes taken I consider of some importance, as the first essential for the forming of an opinion on the physical features of a locality is to actually go over the ground. I confess I went to Mount Kosciusko fully prepared to see the evidences of glaciation as observed by the authors referred to. Mr. Helms regrets "that time did not permit to make closer observations," and speaks of a lake "which like all the other features received only a passing glance."‡ I have no desire to dictate conditions to other writers, but when important conclusions are voluntarily placed on record, in the pages of a scientific publication, I think the authors should hardly plead want of time as an excuse for hasty observation. Dr. Lendenfeld certainly does not complain of want of time, but I am aware that he did not spend more than a few days on Mt. Kosciusko, so that his observations must have been of the nature of a general reconnaissance rather than a detailed examination. To guard against hasty conclusions, I undertook a second journey to Mt. Kosciusko, and, with the conditions of excellent weather and ample time, I made the observations embodied in this paper.

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* Proc. Linn. Soc. N.S.W. (2nd Series), Vol. viii. p. 349.

† *Loc. cit.*, p. 352.

‡ *Loc. cit.*, p. 364.

Before dealing with my own observations, it is convenient to note that Dr. Lendenfeld found the strongest evidences of glaciation in the Wilkinson Valley. Now, Mr. Helms admits that wherever else he saw evidences of glaciation, he certainly saw none in the Wilkinson Valley, and just in the same way as Mr. Helms could see no evidence of glaciation, where Dr. Lendenfeld found such evidences to abound, I confess I have failed to see evidences of glaciation in any one of the localities indicated by Mr. Helms. Mr. Helms issued a map with his paper, on which map he coloured certain places (in blue) where what he terms "glacier traces" are specially pronounced. He also marks certain limited areas (in black) which he calls snow fields. From my standpoint these glacial traces have no existence, and as for the snow fields, I am able to say that on 20th January, 1896, there was not a square yard of snow on any part of the Kosciusko Plateau. I cannot, therefore, agree with Mr. Helms' opinion that "they never entirely disappear even in the hottest summers, and it may safely be said that they remain permanent over the limited area."

I leisurely examined every tract of country coloured blue on Mr. Helms' map; and, taking that map as a basis, I will deal with the so-called glacial traces, beginning with those immediately under Mt. Kosciusko. There is one thing to be noted about this map that has caused a good deal of confusion: Mr. Helms (following Dr. Lendenfeld) calls the highest peak Mount Townsend, and I have satisfied myself that he was not justified in so doing. To begin with, Dr. Lendenfeld ascended a mountain which *his guides told him was Mt. Kosciusko.** He discovered another peak a mile to the south, which he found to be higher than the peak pointed out to him as Mt. Kosciusko. Thereupon he names this highest point Mt. Townsend. One of the residents of Monaro, Mr. John Barry, assured me that tourists were usually taken to a peak which he was well aware was not Mt. Kosciusko. Dr. Lendenfeld was misled in this way. When speaking of Mt. Kosciusko in this paper, it will be understood that I refer to the peak due south of Lake Albina, and called by Dr. Lendenfeld Mt. Townsend. There is another point about Mr. Helms' map. He speaks of various mountains on the Plateau as Mt. Etheridge, Mt. David, Mt. Tenison-Woods, Mt. Townsend, etc. This I think most undesirable. The whole mountain, as well as the highest point, should be called Mt. Kosciusko, and other eminences of note might be called peaks. It would be more satisfactory to speak of the Etheridge Peak, the David Peak, etc., and *Mount* Kosciusko.

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* There was no other means of judging. No accurate maps were available at the time of Dr. Lendenfeld's visit. All that is really known is that Strzelecki named the highest peak, or what he took to be the highest peak, Mt. Kosciusko. Dr. Lendenfeld assumes too readily that Strzelecki did not ascend the highest point, although the distinguished Polish traveller had quite as many facilities for observation as had Dr. Lendenfeld. It must be remembered also that the two peaks, Mts. Townsend and Kosciusko, are within an easy walk of each other.

Coming now to the evidences of glaciation, I first examined the valley of the Crackenback River. Dr. Lendenfeld is very definite in stating that "there was a small glacier at the head of the Crackenback."* Dr. Lendenfeld has not stated that he examined the country at the head of the Crackenback. I have reason to believe that he was never there. But as the statement is so very definite, I expected to find some evidence that the glacier once existed. In order to examine the country thoroughly, I left the beaten track and crossed over from Moonbar to the Mowambar or Moonbar River, and followed that stream by easy stages to its very source. I then crossed the divide to the head of the Crackenback. The rocks consisted entirely of granite in many varieties. No volcanic rocks or dyke rocks were observed. A portion of the valley was extensively turned over in times past by alluvial miners in search of gold. Around the old shafts the alluvial deposits may still be seen, consisting of boulders, shingle, and pebbles of granite, showing little or no signs of decomposition. Nowhere in the valley of the Crackenback or at its head could I find any traces of grooved or scratched pebbles, or any features that would suggest *Roches Moutonnées.* Neither could I find any trace of Moraines. Very often masses of boulders might be noted, evidently transported from higher ground; but neither the boulders, nor the detrital masses of which they form a part, gave the least indication of glacial action. Undoubtedly, as Mr. Helms puts it, "rocks showing rounded, concave, and level surfaces"* are abundant. But most certainly none of these features can without strong collateral evidence be attributed to glacial action. From the Crackenback Valley I travelled along the main range to the foot of Mt. Kosciusko. Naturally I turned to the Wilkinson Valley for some of the evidence that Dr. Lendenfeld found so abundant. I camped here for a week, but long before that time elapsed I was forced to the conclusion that Dr. Lendenfeld was utterly mistaken in attributing any of the features in the Wilkinson Valley to glacial action. Thus far Mr. Helms agrees with me. Dr. Lendenfeld is very definite in his statement that he "found glacier-polished rocks in several places."† Mr. Helms could see none of these polished surfaces in the Wilkinson Valley. Let me add that I could see none of them either. In despair at finding any of the traces that were so evident to Dr. Lendenfeld, I decided to visit other places indicated on Mr. Helms' map as affording the "glacier traces." This map appears as Pl. XVIII. in Proceedings of this Society (2nd Series), Vol. viii. Map in hand I journeyed to Lake Albina, on which lake Mr. Helms shows a peninsula jutting into the lake, and he colours this peninsula blue, as affording evidence of "glacier traces." Here is a photograph showing the lake and the peninsula. (Pl. xxxvii., fig. 1). In the picture there is nothing to be seen suggestive of ice action. On examining the place itself there is absolutely nothing to be found indicative of ice-action. There is in fact no feature about the lake, the cliff, or the talus at its base, that may not be amply accounted for by forces actually in operation. Indeed, the more closely I examined the talus at the base of the cliff beyond the lake, the more astonishing it seemed that any feature observable could, in the most distant way, suggest ice action. Indeed, I will go further and say that if the evidences in favour of glaciation on every point of the Plateau were overwhelming, if we could point to grooves, furrows, scratches, moraine deposits, and boulder masses, and if we had an abundance of *Roches Moutonnées*, I would still make exception of the shores of Lake Albina, and conclude that there, at any rate, no traces of glacial action were in evidence, and nothing suggestive of ice action was preserved. I lingered a day longer in this locality in the hope that any evidence however slight might be forthcoming in favour of the position taken up by Dr. Lendenfeld and Mr. Helms. Nothing more was discovered, and, therefore, I place it on record that in my opinion there is nothing to the eye of the geologist indicative of ice action on the shores of Lake Albina. Turning again to Mr. Helms' map we find that there are tracts coloured blue, in a line directly under Lake Albina; in other words, in a direct line south-east of the lake. To prevent any confusion, it may be noted that one of these blue patches covers the word "dividing," and the other is situated on the Snowy River, between its source and the junction of its first affluent on the right bank. I took special pains to locate these two areas, and in fact examined every square yard of the ground. Once again I was forced to conclude that Mr. Helms has misinterpreted the facts observable; I could not find anything whatever of his "glacier traces." There is abundance of what Mr. Helms calls rock débris. "We could observe," remarks Mr. Helms, "extensive flats with large rocks sticking out of the surface here and there, and bogs all over them"; but I am utterly unable to see what grounds there are for Mr. Helms' conclusion that "these flats have been formed by ice."* Three miles to the south of the Perisher, as shown in Mr. Helms' map, two other areas may be noted, coloured blue, as showing glacier traces. There is some difficulty in determining the exact position of these areas, as the map is not quite accurate here in the contour of the hills. I am not prepared to state absolutely that I found the identical place referred to by Mr. Helms, and on that account I cannot be too positive. I cannot believe, however, that I did not actually traverse the ground, the locality not being far from the main track, but nothing at all suggestive of ice action caught my eye. As Mr. Helms does not refer particularly or definitely to these two places, I pushed on and formed a camp at Pretty Point, so as to be centrally situated in the most extensive glaciated areas shown on Mr. Helms' map. Mr. Helms is very definite in his conclusion concerning this locality, and speaks about an open grassy flat at Wilson's Valley. This valley he says "may safely be considered attributable to glacier action."* A few lines further on he says, "entering the flat we stand on Boggy Plain and upon an unmistakable glacier deposit." This I consider the most astonishing statement in Mr. Helms' paper. The assertion simply bewilders one. I cannot conceive how such a conclusion could have been reached: to my mind this one fact is abundantly, unmistakably clear—Boggy Plain is not a "glacier deposit." There is nothing that one can appeal to, nothing that one can point to, indicative of ice action. "Proceeding," says Mr. Helms, "the evidence of ice action is becoming more plentiful at almost every turn." I have to state simply that I saw nothing of the sort. This was not attributable to any want of care or observation on my part. I went to the Kosciusko Plateau believing that evidences of glaciation were abundant, and it was with the utmost reluctance that I was forced to come to the conclusions here recorded.

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* Proc. Linn. Soc. N.S.W. (1st Series), Vol. x. p 53.

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* Proc. Linn. Soc. N.S.W. (2nd Series), Vol. viii. p. 352.

† Proc. Linn. Soc. N.S.W. (1st Series), Vol. x. p. 47.

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* Proc. Linn. Soc. N.S.W. (2nd Series), Vol. viii. p. 353.

The value of Mr. Helms' observations could be tested critically on Boggy Plain. Nowhere is he so definite in his statements as when speaking of Boggy Plain. I decided on this account to examine the plain thoroughly, and nothing could be easier than such an examination. The season was a fairly dry one, and a number of shafts had been sunk some years ago, during a particularly dry season, at various points on the plain in search of gold. These shafts were put down in exactly the way a geologist would like to have them, namely, in the "deepest ground," as it was the miners' desire to get through the drifts on to bed rock, in their search for gold. I was agreeably surprised to find in these shafts boulders of pure quartz, quartz-porphyry, and diorite, the two last-named rocks being for the most part perfectly sound, and showing very little signs of decomposition. I exhibit some of the boulders collected by me. They are just of the right material and in the proper state of preservation to show any traces of grooving or scratching—if grooved or scratched they ever had been. Take this boulder of diorite, for instance, the very finest scratches would be preserved here, had they ever been made. I examined hundreds of stones of this sort out of the shafts from positions where a geologist would have selected them, had the shafts been sunk for his own particular use, but never once did I find a grooved boulder, or striated pebble, or a polished surface. The stones in these shafts are not angular, but, on the contrary, well water-worn and rounded. Mr. Helms points out that polished surfaces are not to be expected, nor grooves nor striæ to be looked for on the gneissic granite and slate rocks, as he observes "they would not retain polish or striation for any length of time." Indeed, Mr. Helms' paper would lead one to believe that slate and gneissic granite were the only rocks on the plateau. I would point out that there is basalt a short distance from the top of Mt. Kosciusko. There is basalt also a little to the north of Mt. Townsend. There is a picrite-basalt at Lake Merewether, and quartz-porphyry and diorites must be abundant from the quantities of boulders of these rocks found in the shafts. Let me insist on the fact that *all* the boulders in the shafts on Boggy Plain are water-worn; even the blocks of quartz are rounded. If these water-worn stones are the work of a glacier, I can only say that every alluvial gold-field in New South Wales is rich in "glacial traces"—a somewhat absurd, but necessary conclusion.

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* Proc. Linn. Soc. N.S.W. (2nd Series), Vol. viii. p. 354.

Abandoning all hope of here finding support for Dr. Lendenfeld's "Glacial Period in Australia," I turned to the valley named on Mr. Helms' map Glacier Valley. There is little to be gained by describing this valley and its rocks in detail. Nothing that I saw altered the opinion already expressed. Rounded rocks there are, and smoothed rocks also, with contours that probably *could* be produced by ice, but on a critical examination even that probability vanishes.

There remains but one other tract on Mr. Helms' map to deal with. This is the area around Lake Merewether, named Evidence Valley, I presume on the "lucus a non lucendo" principle. There are many features in this tract that may require or suppose the existence of ice-sheets and snow-fields, and the violent action of heavy streams of water flowing under ice; but there is nothing to warrant one's supposing the existence in the past of *moving* ice.

Some of the individuals of the large rock masses in this valley are strikingly angular. A photograph (Pl. xxxviii., fig. 2) will show the actual breaking up of granite into rectangular blocks by natural weathering. Many of these blocks are as rectangular as if hand-dressed from a quarry. The vast piles of blocks, many of them of this description, between the Hedley Tarn and the Snowy River, are a somewhat exceptional occurrence. I should not, however, feel justified in supposing *moving* ice to have brought these massive rocks together. Other collateral evidence ought to be forthcoming of the existence of glaciers. I mean by collateral evidence, such evidence as is afforded by scratches, grooves, and furrows on rocks, boulder clays, angular blocks, *Roches Moutonnées*, perched blocks, transported blocks, moraines and moraine deposits.

In accounting for the origin of masses of boulders in such a region as that we are dealing with, it may be well to bear in mind that the forces of disintegration and decomposition are far more intense in their action here than under normal conditions. We should remember, too, that we are dealing with possibly one of the oldest land surfaces on the globe. The destruction by weathering, including in that term disintegration and decomposition, must be enormous on mountain peaks like Mt. Kosciusko. Many of the great packs of loose rock material have no doubt been formed by selective process, the smaller stones being carried away where heavier masses remain. I have noticed immense blocks undoubtedly carried a short way down some valleys—blocks which one could hardly suppose were carried by running water. I can see no reason, however, for assuming that ice was the transporting agent. By a continuous undermining (by running water) of the softer materials on which they rested, they could easily have been moved into their present positions.

Some of the granite rocks to the south and west of Lake Merewether have a decidedly rounded and smoothed appearance, but not more pronounced, I should say, than that familiar to every geologist in the granite districts of New England and even in the neighbourhood of Bathurst and Cowra.

I repeat that it may be necessary to assume the existence of thick sheets of ice to explain some of the features noted, and we may even utilise valleys filled with snow, over the frozen surfaces of which boulders may have slid; but assuredly there is no feature in Evidence Valley that requires moving ice to explain it.

Dr. Lendenfeld and Mr. Helms have assumed throughout that there is above their supposed glaciers a gathering ground where snow could accumulate and consolidate into ice, and so form a feeding ground for the glaciers. A few hundred yards from the great glacier, supposed by Mr. Helms to have come down from Mt. Twynam, we have the very summit of a sharp divide, with a rapid fall away on the other side. We have, in fact, a glacier without a gathering ground, a condition of things not easy to understand. Dr. Lendenfeld in like manner fills the Wilkinson Valley with a glacier. The learned doctor from his experience very well knew that a glacier must have a gathering ground. Following up the Wilkinson Valley from the point where Dr. Lendenfeld makes his glacier do most of its work we come, in about half a mile, to the summit of the divide, from which point another valley dips away on the opposite side. It is reasonable to ask: where were the snow-fields and the gathering ground for the glacier of the Wilkinson Valley? Dr. Lendenfeld replies by assuming their existence, and from my standpoint as a geologist I protest against this assumption on his part. Take Dr. Lendenfeld's plate of the Wilkinson Glacier (Proc. Linn. Soc. N.S.W. Vol. x. Pl. 7), sketched from Mt. Townsend (our Mt. Kosciusko). It will be noted that away to the back of the range, showing as he says polished rocks "en face," he makes mountains rise tier above tier. Pl. xxxvii., fig. 2, is a photograph taken from approximately the same spot that Dr. Lendenfeld sketched from. It will be noted that there are no mountains rising above or beyond the range across the valley, and more than that I assert that standing on the very highest point of Kosciusko (Mt. Townsend of Lendenfeld) and looking in the direction in which the Doctor sketched, no mountains or table-lands are visible above the range across the valley. In other words, the view is bounded in that direction by the outline of the range, round the base of which Dr. Lendenfeld asserts the glacier wound. The long stretches of great mountains that appear on Dr. Lendenfeld's plate as showing above the Abbott Range, when seen from Mt. Townsend (our Kosciusko), do not exist. In a word, a serious difficulty in the case of the supposed Wilkinson glacier, and the supposed Helms glacier described as coming over Townsend, is that these glaciers have no place to come from. It may be argued that the plateau, which must be postulated in each case, has disappeared by being denuded away. Possibly, but if these great mountains and plateaux have been planed down, since the "glacial period," there is little hope for the polished rocks of Dr. Lendenfeld, or the rounded rocks of Mr. Helms, being preserved. Either supposition is fatal to the position taken up by Dr. Lendenfeld and Mr. Helms.

Before concluding I may say that, at several points on the plateau, I found polished or rather smoothed faces on rocks. In every instance this was due to slickenside. On the end of a ridge that bounds the valley of the stream that flows from the Garrard Tarn I noted a surface of several square yards of *polished* rock. The rock was a micaeous slate, and I was somewhat puzzled to account for the polish on so soft a rock. Besides, the polished surface stood nearly vertical. This of course *could* be caused by moving ice, by supposing the valley to be filled with a glacier. On examining the specimens by slicing them for the microscope, I found that the polish was due to a thin coating of silica. Now a glacier may smooth a rock and polish it, but certainly not coat it with silica. The explanation is that the point at which I collected my specimen is close to the boundary of an intrusive granite. The slate is much faulted, broken, and contorted, and the specimen referred to is part of a slickenside formed at the time of the intrusion of the granite.

So far I have not alluded to the evidences of glacial action in recent times that have been described as occurring to the South of Mt. Kosciusko and for the most part within Victorian borders. Many of the descriptions published are circumstantial in every way and cannot be lightly put aside. As I have not been over the ground I cannot offer any criticisms from my own knowledge. It seems to me, however, that in most of the instances quoted the characters referred to glacial action could have been as well attributed to other causes. In a word, if overwhelming evidence was forthcoming as to the glaciers described by Dr. Lendenfeld having existed in fact, then features that could have been produced in another way might safely be attributed to glacial action. The instances cited seem to me something in the nature of collateral evidence depending entirely for its value on the *fact* of a glacial period. Mr. R. M. Johnston* has summarised the papers referred to in a manner which leaves no doubt of the great weight of evidence that has gradually accumulated in favour of recent glacial action. I refer to this evidence merely to point out that it cannot be ignored, and to emphasize the fact that this paper deals only with Mt. Kosciusko and the country immediately round: a tract that may be defined as embraced in the map published herewith as well as that published by Mr. R. Helms.†

My conclusions may be summed up as follows:—I have been over the same ground as Dr. Lendenfeld and Mr. Helms. I could not but agree with Mr. Helms as to the absence of any evidence of glaciation such as Dr. Lendenfeld had reported in Wilkinson Valley. But I also feel compelled to differ from Mr. Helms in respect of the other localities in which he believed he had detected evidence of "glacier action," as indicated on the map accompanying his paper; and I am forced to the conclusion that the evidence adduced is wholly insufficient, and that no striæ, groovings or polished faces (due to ice-action), or *roches moutonnées* perched blocks, moraine-stuff, or erratics are to be met with. Only one example of anything like a polished block was noted, and in this case the polishing and striæ-like markings were clearly due to a "slickenside." Most of the granite is of a gneissic character, but normal granites are also present, the latter weathering into spheroidal masses of disintegration, the contours of which in a few cases are suggestive of ice action. There is no collateral evidence to support any such suggestion. It has been stated that the rocks on the plateau are not such as would preserve glacial striæ. This is not strictly in keeping with fact, as I found porphyries, diorites and basalts, as well as abundance of quartz pebbles and boulders in the drifts. Apart from local evidence, the general contour of the valleys is not in the least suggestive of glaciers. I therefore concluded that (1) there is no satisfactory evidence of glaciers having once filled the present valleys; (2) there is absolutely no evidence of extensive glaciation on the Kosciusko Plateau; (3) The glacial epoch of Australia in Post-Tertiary times, as described by Dr. Lendenfeld, has no foundation in fact. Neither are there any snow-fields with "eternal snow," however limited, on Mt. Kosciusko.

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* Papers and Proceedings of the Royal Soc. of Tasmania for 1893, p. 73.

† Proc. Linn. Soc. of N.S.W. (2nd Series), Vol. viii. p. 349.

Postscript.—After this paper was written a paper embodying an extended series of observations on evidences of glacial action on the Australian Alps across the Victorian border was read to the Sydney Meeting of the Australasian Association for the Advancement of Science by Messrs. Kitson and Thom. It seems to the present writer that the case made out by these authors in favour of recent glacial action in the Australian Alps is no stronger than that of Dr. Lendenfeld and Mr. R. Helms.

EXPLANATION OF PLATES.

Plate XXXVII.

Fig. 1.—Lake Albina (Mt. Kosciusko in the distance to the left). This picture is taken from a ridge North from Mt. Kosciusko, and the peninsula jutting into the lake is that distinctly marked on Mr. R. Helms' map as preserving "glacial traces." All the country shown here is above the tree-line. The gully, seen in the distance, forming a feeder to the lake, marks the exact line of junction between slate and granite country. The hills to the right are slate; Mt. Kosciusko itself and the country to the left of the gully are granite varying from typical to gneissose granite.

Fig. 2.—This photograph is taken approximately from the western shoulder of Mt. Kosciusko, and from approximately the same point as that from which Dr. Lendenfeld made his sketch shown in Vol. x., Plate 8, of the Proceedings of this Society. Mueller's Peak (Mt. Townsend) is seen in the distance to the right. Looking in the same direction from which this photograph was taken no ridges are visible above the horizon shown. This may be said even of a view taken from the very summit of Mt. Kosciusko. The country shown is all above the tree-line.

Plate XXXVIII.

Fig. 1.—The Garrard Tarn. There is no tarn or lake in Kosciusko that affords direct evidence of ice-action. The tarn shown is, in the author's opinion, a dammed up elbow of an ancient stream; but immediately in the background a cirque or corrie may be seen in course of formation which will in time form an independent tarn or add to the area of the tarn figured.

Fig. 2.—A little to the N.E. of Lake Merewether, granite may be seen breaking up into the angular blocks shown. The sheeted structure of much of the granite on the plateau lends itself to the production of vast masses of detrital matter in which the granite boulders show parallel and plane faces. When this sheeted granite is traversed by joints, weathering gives rise to large quantities of angular blocks.

Plate XXXIX.

The Kosciusko Plateau showing the author's route and all the known lakes and tarns.